USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

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Major Forest Insect and Disease Conditions in the United States: 2021

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Acknowledgements

The annual forest conditions report provides information generated through the combined efforts of U.S. Department of Agriculture (USDA), Forest Service employees; State agencies; and other partners. Their dedication to the monitoring, detection, suppression, treatment, and management of our forested lands for insects and disease makes this report possible.

Report compiled by S. Sky Stephens, Sheryl A. Romero, and Frank J. Krist (USDA Forest Service, Forest Health Protection).

Photo credit

Cover photo: Fall colors in the Flathead National Forest. Photo by USDA Forest Service.

Copies of this report are available from:

U.S. Department of Agriculture, Forest Service
Attn: Forest Health Protection
1400 Independence Avenue, SW
Stop Code 1110
Washington, DC 20250–1110

Email: stephanie.s.stephens@usda.gov

This report and other Forest Health Protection materials can be found online at:
https://www.fs.usda.gov/foresthealth

Forest Health Protection Offices/Regions

USDA Forest Service
Washington Office
Stop Code 1110
1400 Independence Avenue, SW
Washington, DC 20250–1110
703–605–5344

USDA Forest Service
Northern Region (R1)
Federal Building
200 East Broadway
P.O. Box 7669
Missoula, Mt 59807–7669
406–329–3308

USDA Forest Service
Rocky Mountain Region (R2)
1617 Cole Boulevard, Building 17
Lakewood, CO 80401
303–275–5350

USDA Forest Service
Southwestern Region (R3)
333 Broadway Boulevard, SE
Albuquerque, NM 87102
505–842–3247

USDA Forest Service
Intermountain Region (R4)
324 25th Street
Ogden, UT 84401
801–625–5759

USDA Forest Service
Pacific Southwest Region (R5)
1323 Club Drive
Vallejo, CA 94592
707–562–8921

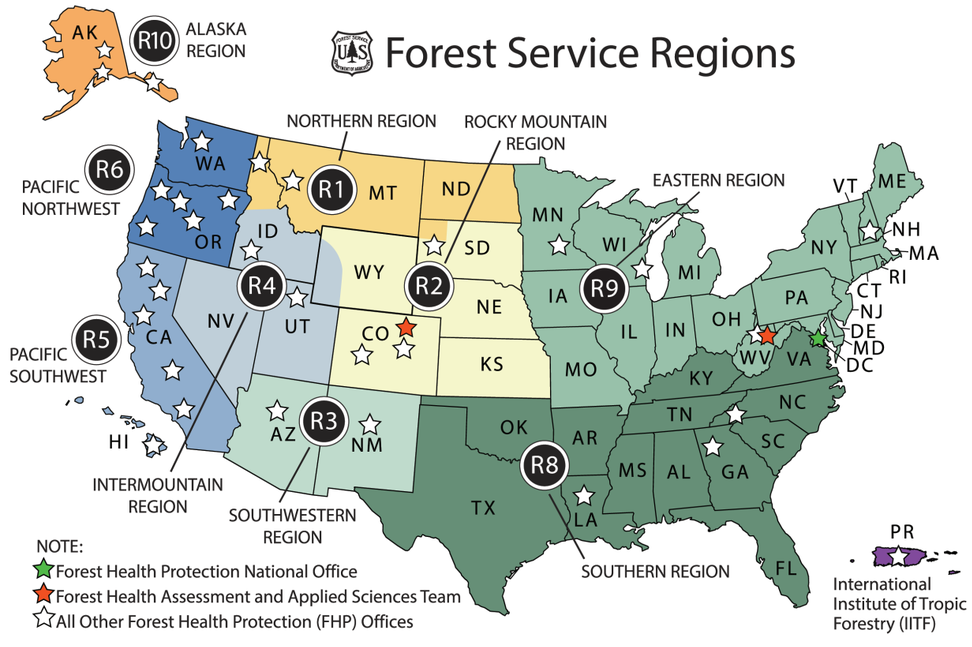
USDA Forest Service
Pacific Northwest Region (R6)
1220 SW 3rd Ave.
Portland, OR 97204–3440
503–808–2913

USDA Forest Service
Southern Region (R8)
1720 Peachtree Road, NW
Atlanta, GA 30309
404–347–3540

USDA Forest Service
Eastern Region (R9)
626 East Wisconsin Avenue
Milwaukee, WI 53202
414–297–3600

USDA Forest Service
Alaska Region (R10)
3301 C Street, Suite 202
Anchorage, AK 99503–3956
907–743–9455

USDA Forest Service
International Institute of Tropical Forestry
Jardín Botánico Sur,
1201 Calle Ceiba
San Juan, Puerto Rico 00926
787–766–5335



Preface

This report on the major insect and disease conditions of the Nation's forests represents the 71st annual report prepared by the U.S. Department of Agriculture, Forest Service. The report focuses on major insects and diseases that annually impact our Nation's forests. This 2021 update provides a national summary of the major changes and status of major forest pests with updated charts, tables, and maps. Additional information on these and other pests is available at: https://www.fs.usda.gov/foresthealth/.

The information in this report is provided by the Forest Health Protection program of the Forest Service and its State partners. This program serves all Federal lands, including National Forest System lands, lands administered by the U.S. Departments of Defense and the Interior, and Tribal lands. The program also provides assistance to private landowners through State foresters and other State agencies. Key elements of the program are administered by Forest Service and State program specialists to detect and report insect and disease epidemics through annual detection and monitoring surveys.

For additional information about forest health conditions, contact a Forest Service office (see map for office coverage) or your State forester.

CONTENTS

IMPORTANT: *When interpreting maps throughout this document, note that data are displayed at the county scale only. For example, if damage was reported at just one location in the county, the entire county is displayed as affected. This standard convention is used because data for most pests are collected only at the county level. If the damage was reported at finer scales, many areas would not be visible at the scale used in this publication. The maps represent only what is reported as mortality or defoliation and not the total infestation of a particular pest. In any given year, some areas are not surveyed due to physical limitations, such as forest fires, weather events, or limited resources. Data collected from ground and aerial surveys used in this report represent a single snapshot in time for a given year. More frequent surveys are conducted in specific areas on a case-by-case basis. By combining these surveys over time, this report captures general trends and conditions of selected insects and diseases across multiple years.*

Introduction

423 MILLION ACRES surveyed in 2021

5.8 MILLION ACRES with dead trees in 2021

5.7 MILLION ACRES with other tree damage in 2021

Insects and diseases play critical roles in maintaining healthy, resilient ecosystems. They also can be among the most serious economic and environmental threats to the forests and urban landscapes in the United States. Trees respond to environmental cues and may be positively or negatively impacted by these changes, altering ecosystem services derived from forested lands, including timber, recreation, tourism, clean water, energy, wildlife habitat, and jobs. To understand how conditions are changing and to protect species, forests are surveyed for insect and disease extent and intensity on an annual basis. Federal and State agencies and other stakeholders work together to use this information for management to ensure resilient forests are sustainable into the future. The overall mortality caused by insects and diseases varies by year and by pest, and cumulative effects can cause significant change.

COVID-19 IMPACTS

Insect and disease surveys for 2021 were minimally impacted by the COVID-19 pandemic. Many regions and States were able to conduct a more typical survey season than in 2020. Aircraft and surveyor availability were sometimes limited by COVID-19 factors. Overall, **423 million acres were surveyed** in 2021, which was a significant increase from 215 million acres in 2020, but still short of the 500 million surveyed in 2019.

TREE MORTALITY

In 2021, **more than 5.8 million acres of tree mortality** caused by insects and diseases was observed in the United States. The total tree mortality reported in 2021 is incomparable to the tree mortality reported in 2020 due to the reduction in surveyed acres in 2020. In some areas, specific queries can be made to identify localized change where surveys were completed in 2019 and 2020.

Every year, hundreds of native and nonnative insects and diseases damage our Nation's forests. This report provides descriptions of major insects and diseases that contribute to annual tree mortality and damage. Additionally, our "Feature" section describes pests that the Forest Service and its partners are closely monitoring. While each pest is reported separately, multiple pests may be active in the same area causing mortality to multiple host trees, magnifying the change in forest condition and creating complex forest management challenges.

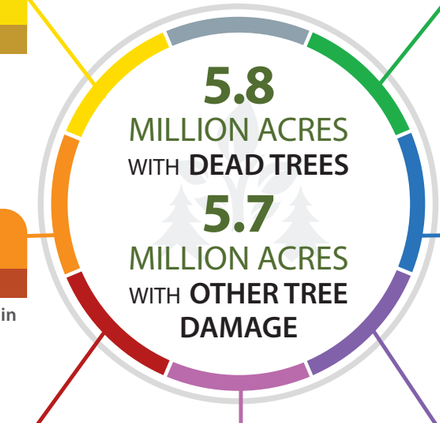
For more information on all the mortality and damage agents, please visit:

https://www.fs.usda.gov/foresthealth/

In addition to mortality, defoliating pests can damage trees by eating leaves or needles, causing significant losses of foliage and altering forest health. A single defoliation event does not usually cause tree mortality; taken together with repeated attacks or severe abiotic factors, such as weather and drought, trees can succumb to these defoliating insects or be predisposed to other insects and disease impacts. In 2021, surveys identified **5.7 million acres of defoliation and other types of damage.**

2021 HIGHLIGHTS OF TREE MORTALITY AND OTHER DAMAGE FROM INSECTS AND DISEASES

*423 million acres surveyed



SUDDEN OAK DEATH
OAK AND TANOAK

- **New detections** occurred in Oregon **prompting quarantine expansion**
- First detection in Oregon of the NA2 lineage in a forest, **bringing the total variants in the wild to three**

SOUTHERN PINE BEETLE
SOUTHERN PINES

- Northernmost trap detection **occurred in southern Maine**
- **Mortality is scattered** across the Southeastern United States

EMERALD ASH BORER
ASH

- **Continues to spread** to additional counties in infested States, but no new States in 2021
- **Ash mortality is extensive** in impacted natural forests and communities

RAPID 'ŌHI'A DEATH
'ŌHI'A

- *Ceratocystis lukuohia* is one of two strains of fungi that cause ROD and **accounts for roughly 90 percent of detections**
- **New detections** in high-value native forests are reported each year

OAK WILT
OAK

- An **aggressive tree disease** of red oak species
- **Actively spreading** among oaks damaged or trimmed during April, May, or June each year

SPONGY MOTH
HARDWOODS

- **2.5 million acres** with defoliation **reported**
- **1.3 million acres** is the **most extensive defoliation** ever documented in Michigan

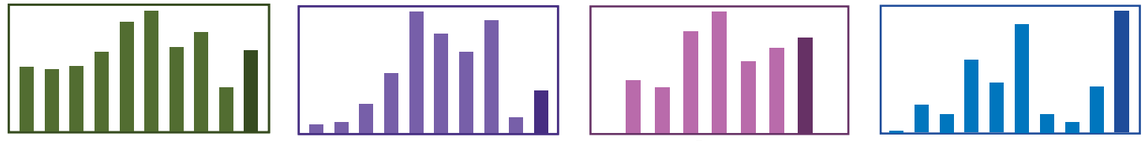
FIR ENGRAVER
WESTERN FIRS

- **Drought conditions increased** fir mortality
- **1 million acres** with tree mortality was reported

ACTIVITIES SUPPORTED BY FOREST HEALTH PROTECTION

SUDDEN OAK DEATH	SOUTHERN PINE BEETLE	EMERALD ASH BORER	RAPID 'ŌHI'A DEATH	FIR ENGRAVER	SPONGY MOTH	OAK WILT
Detection survey, targeted treatments, and containment	Suppression of active infestations and thinning forests for prevention	Providing technical assistance and outreach	Detection survey, rapid response, sanitation, and resistance screening	Surveying, suppression, and developing management options	Eradication, suppression, and Slow the Spread Program	Detection, suppression, and developing management options

TREE MORTALITY SURVEY TRENDS 2012–2021*



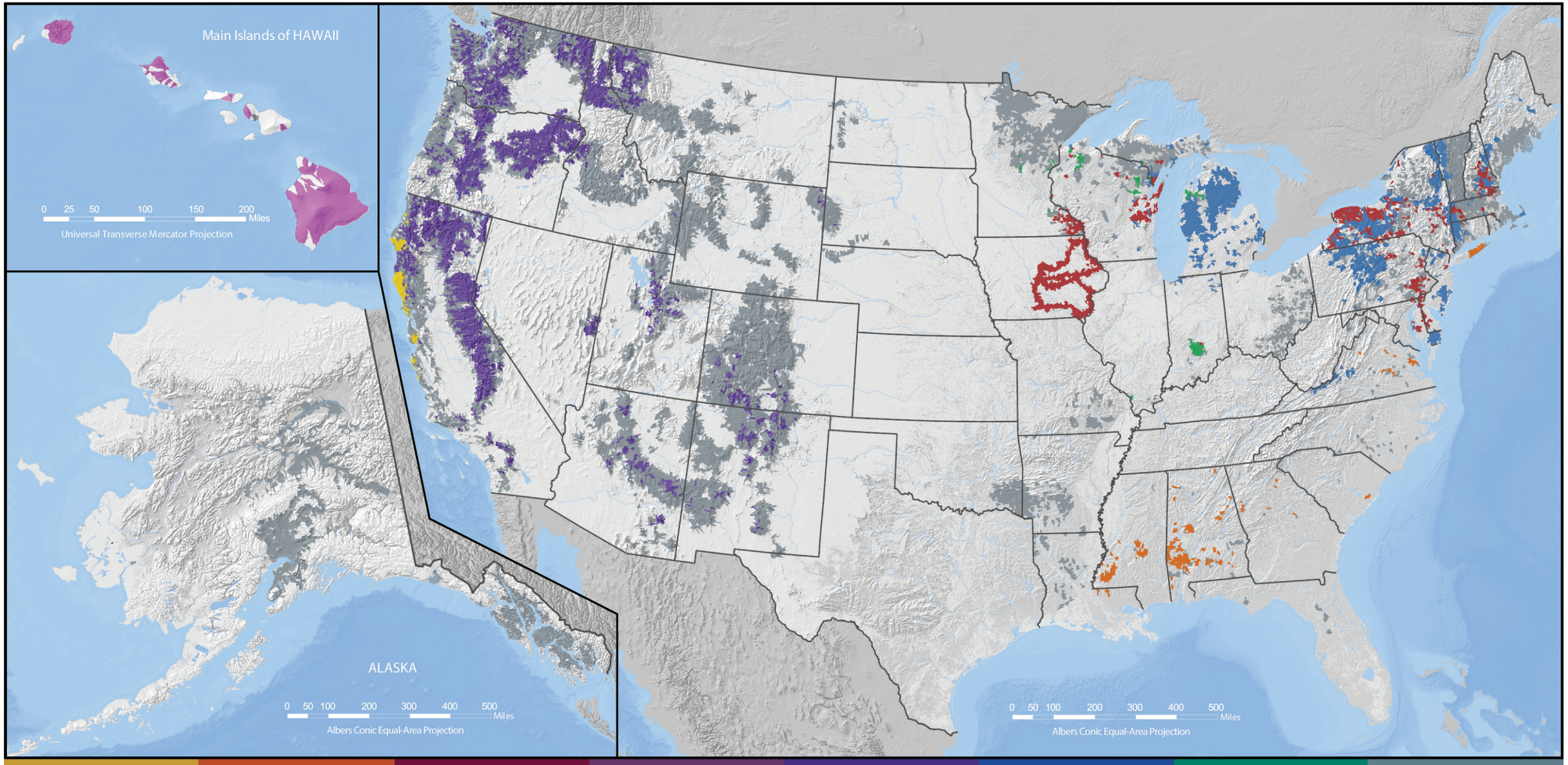
ALL TREE MORTALITY **5.8 MILLION ACRES** IN 2021

FIR ENGRAVER **1MILLION ACRES** IN 2021

RAPID 'ŌHI'A DEATH **90,000 ACRES** IN 2021

SPONGY MOTH **2.5 M DEFOLIATION ACRES** IN 2021

2021 INSECT AND DISEASE SURVEY—WATERSHEDS WITH TREE DAMAGE



Sudden oak death | Southern pine beetle | Emerald ash borer | Rapid ʻōhiʻa death | Fir engraver | Spongy moth | Oak wilt | ** Other damage

**Includes damage from spruce budworm, western blackheaded budworm, spruce beetle and other western bark beetles, eastern larch beetle, hemlock sawfly, browntail moth, beech leaf disease, and many other less significant pests.

Yellow-Cedar Decline

Abiotic issue of *Callitropsis nootkatensis*

Culturally valuable tree faces climate change challenges.

Yellow-cedar forest showing a mix of dead, dying, and healthy yellow-cedar. Photo by Robin Mulvey, USDA Forest Service.

Yellow-cedar is an economically important tree in southeast Alaska. Yellow-cedar is a long-lived species and is the most commercially valuable tree species in Alaska. Yellow-cedar decline, caused by root-freezing injury in the absence of insulating snowpack, is the most significant threat to yellow-cedar. Yellow-cedar decline tends to occur at higher elevations in yellow-cedar forests in the southern panhandle where snowpack levels are the most dynamic. In the southern portion of the range, yellow-cedar decline has already impacted lower elevation forests. Yellow-cedar decline acreage was highest in the 56–58° latitude bands between sea level and 500 feet elevation followed by the 55–56° latitude band at 800–1,200 feet elevation.

In 2021, aerial detection survey recorded over 8,000 acres of yellow-cedar decline. Yellow-cedar decline was difficult to detect in 2021 due to extensive defoliation by the western blackheaded budworm which causes a similar aerial detection signature. Most observed damage was between Prince of Wales Island and the central portion of the Tongass National Forest. Three small pockets of yellow-cedar mortality were mapped along the outer coast of Glacier Bay National Park. Yellow-cedar forests in this area had been considered healthy and ground checks will be needed to confirm yellow-cedar decline.

HOST: **YELLOW-CEDAR**

- ★ Yellow-cedar **is under considerable stress** from abiotic impacts and defoliation
- ★ Yellow-cedar **is an economically important tree** in Alaska

Dead and dying yellow-cedar. Photo by Robin Mulvey, USDA Forest Service.

FOREST DAMAGE AND RANGE

Rapid ʻŌhiʻa Death

Ceratocystis lukuohia and *Ceratocystis huliohia*

New detections in high-value native forests.

ʻŌhiʻa forest showing scattered mortality resulting from rapid ʻōhiʻa death. Photo by Paul Berkowitz, Pacific Island Ecosystems Research Center.

In Hawaii's forests, ʻōhiʻa accounts for 50 percent of all trees and 80 percent of all native trees. Two related fungi—*Ceratocystis huliohia*, a slow spreading canker disease, and *Ceratocystis lukuohia*, an aggressive wilt disease—are the causes of rapid ʻōhiʻa death (ROD). Aerial and ground surveys estimate that the disease kills about 200,000 trees annually.

In 2021, ROD continued to spread on Hawai'i Island, mostly filling in areas where only scattered mortality occurred previously.

Areas with invasive hoofed animals experience higher incidence of ROD. On Kaua'i, ROD has been detected in multiple areas and managers on the island are responding with containment strategies. New detections of ROD in high-value native forests were made in 2021, warranting rapid response. Only *Ceratocystis huliohia* has been detected on the island of O'ahu, while a single detection of *C. huliohia* on Maui was destroyed, and no further detections have been reported on the islands making up Maui Nui.

HOST: **ʻŌHIʻA**

- ★ *Ceratocystis lukuohia* **accounts for roughly 90 percent of ROD detections**
- ★ **New detections** in high-value native forests are reported each year

A formerly pristine ʻōhiʻa forest devastated by the ʻōhiʻa wilt disease. Photo by J. B. Friday, University of Hawai`i.

FOREST DAMAGE AND RANGE

Sudden Oak Death

Phytophthora ramorum

Leaf discoloration symptoms from sudden oak death. Photo by Joseph O'Brien, USDA Forest Service.

First wildland detection of North American (NA2) linage.

Sudden oak death (SOD), caused by *Phytophthora ramorum*, is known to occur in natural forested areas in Oregon and California. It is a federally regulated pest with established quarantines in Curry County, OR, and the State of California.

Survey efforts to detect SOD continued in 2021 and included aerial survey, aerial imagery interpretation, ground transect surveys, and stream baiting.

In 2021, SOD surveys detected two new infestations in Oregon outside of the quarantine area. The first is on the Rogue River-Siskiyou National Forest. The second is just outside Port Orford. Both sites tested positive for NA2, the North American variant of *P. ramorum*, representing a first wildland detection of the linage. Treatment of the identified area, approximately 600 acres, is ongoing as weather and fire-risk conditions allow. In addition, the Oregon Department of Agriculture established two separate 3-mile emergency quarantines until the extent of the new infestations can be determined.

Tree mortality caused by sudden oak death. Photo by Bruce Moltzan, USDA Forest Service.

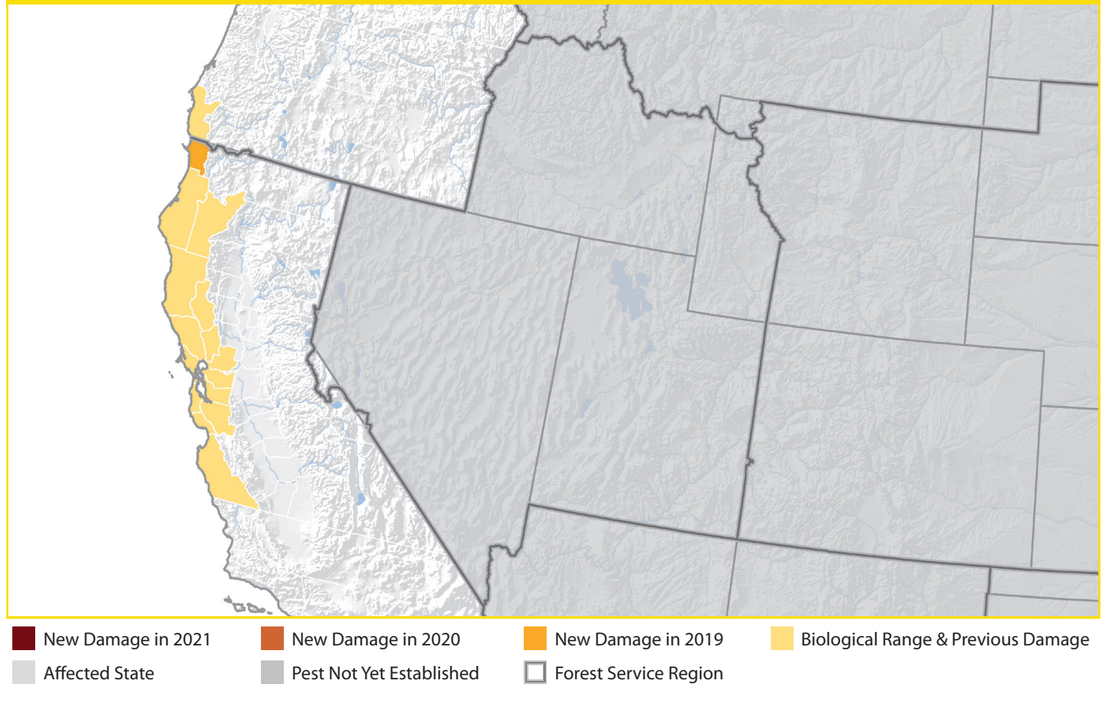
Forest Service aerial detection surveys identified local pockets of SOD in California. Tanoak mortality declined significantly from the previous 2 years. Citizen science "SOD Blitz" surveys determined new infections statewide were generally at lower levels than previous years, likely due to dry winter and spring conditions. Multiple outbreaks were identified in south and west Marin County, and in the Santa Cruz Mountains in both San Mateo and Santa Cruz Counties.

HOST: **OAK AND TANOAK**

- **New detections** occurred in Oregon **prompting quarantine expansion**
- First detection in Oregon of the NA2 lineage in a forest, **bringing the total variants in the wild to three**

Sudden oak death impacts on coastal live oak. Photo by Joseph O'Brien, USDA Forest Service.

FOREST DAMAGE AND RANGE



Southern Pine Beetle

Dendroctonus frontalis

Aerial view of southern pine beetle spot infestation. Photo by USDA Forest Service.

Trap catch in southern Maine prompts additional monitoring.

In 2021, southern pine beetle (SPB) activity was significantly higher than in 2020 but still low compared to historic activity. Some of the increase in activity is attributed to increased surveying after COVID-19 restrictions impacted the 2020 assessment. Scattered infestations of the SPB occurred across the Southern Region including Mississippi and Alabama, and to a much lesser extent Louisiana, Georgia, South Carolina, and Virginia. No tree mortality was reported from North Carolina or Texas. In the Eastern Region, the SPB was reported in traps in Pennsylvania, New Hampshire, Rhode Island, and Maine. Tree mortality or infestation was reported in New Jersey, New York, and Connecticut.

In the Southern Region, SPB activity was reported in "spots"—areas of beetle activity typically less than 1 acre—in Mississippi, Virginia, and Alabama. The Homochitto National Forest and Bienville National Forest in Mississippi saw a significant increase in SPB activity in 2021 after recovering from devastating activity during 2017 and 2018. Larger SPB spots were detected in Georgia; surveyors detected another impacted area of more than 200 acres on the Francis Marion National Forest in South Carolina. This spot likely began in 2020 or 2019 but went unnoticed and unreported due to the cessation of surveying and monitoring due to COVID-19 restrictions.

In the Eastern Region, tree mortality caused by the SPB and monitoring trap catches were generally low. Infested trees were identified in the New Jersey Pine Barrens, Hartford and New Haven Counties in Connecticut, and in the southeastern portion of Long Island, NY. The SPB was collected for the first time in the southmost portion of Maine in York County. Several other States, including Massachusetts, New Hampshire, and Rhode Island, continue to catch the SPB in traps with no associated tree infestations or mortality. Pennsylvania trapped the SPB in two new counties, Dauphin and Huntingdon.

Pitch tubes are evidence of southern pine beetle attacks on host. Photo by Erich G. Vallery, USDA Forest Service.

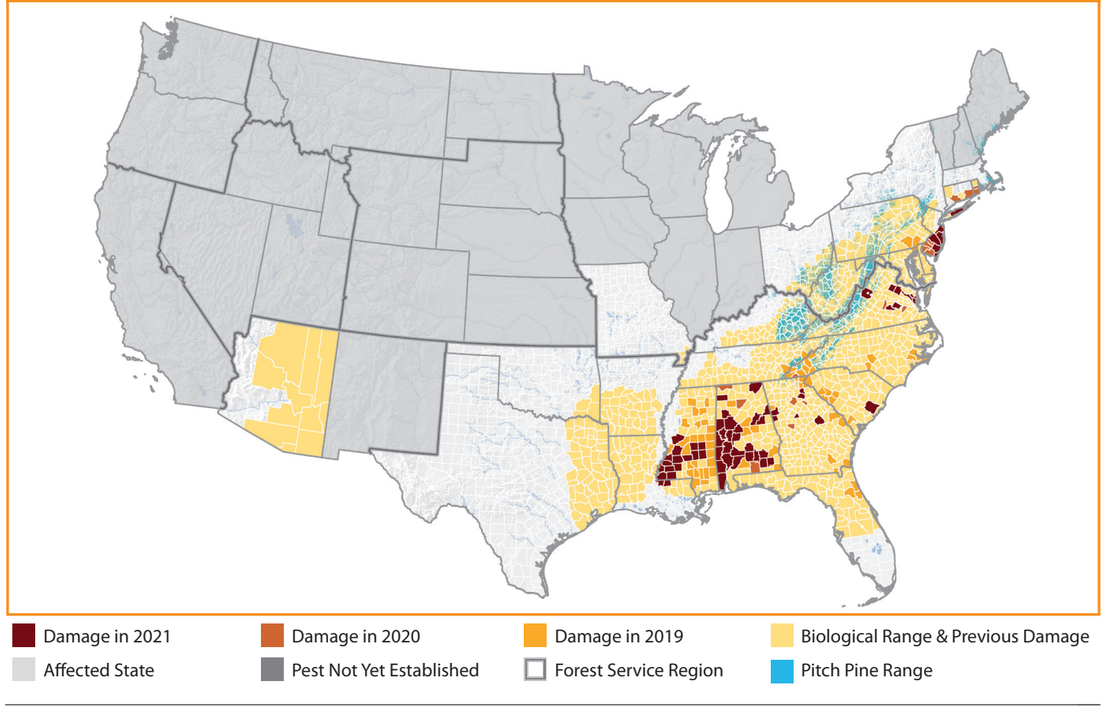
Tree mortality caused by the southern pine beetle. Photo by Ronald F. Billings, Texas A&M Forest Service, Bugwood.org.

HOST: SOUTHERN PINES

- Northernmost trap detection **occurred in southern Maine**
- **Mortality is scattered** across the Southeastern United States

Southern pine beetle adult. Photo by Erich G. Vallery, USDA Forest Service.

FOREST DAMAGE AND RANGE



Emerald Ash Borer

Agrilus planipennis

Emerging emerald ash borer adults. Photo by Debbie Miller, USDA Forest Service.

Infestations continue throughout impacted areas.

The emerald ash borer (EAB) was not found in any new States in 2021. It continued to spread to new counties within the 35 confirmed infested States. The EAB continues to impact urban and natural forests. Surveying, trapping, biosurveillance, and monitoring and detection programs, combined with observations from citizens and green industry professionals, identify and quantify areas impacted by the EAB. Tree loss is a significant concern in newly impacted areas where ash resources are often concentrated in river corridors and in urban landscapes.

In the Eastern Region, the EAB occurs in all 20 States and the District of Columbia including counties in Connecticut, Pennsylvania, West Virginia, Ohio, and Indiana. Nearly all counties in New Hampshire, Vermont, Massachusetts, Rhode Island, New Jersey, Maryland, Wisconsin, and Missouri are impacted.

Throughout the East, mid-Atlantic, and Central States, tree decline and mortality caused by the EAB continued to impact urban and suburban communities and natural forest. Most States continued to identify additional impacted counties and communities. Many of these areas have been impacted for 10–20 years, and tree mortality caused by the EAB has increased significantly. Some areas have experienced almost complete overstory mortality and now have only a few lingering ash. New York recorded over 150,000 acres of ash mortality through aerial detection surveys in 2021. A few States on the western edge of the region have seen less tree loss to date, but anticipate increasing ash mortality.

The emerald ash borer has spread throughout Illinois, Indiana, and much of Iowa where tree mortality appears to be peaking. In Michigan, the Lower Peninsula is generally infested, and infestation is expected to continue its westward spread across the Upper Peninsula where the ash resource is impacted in all but three counties. Most contiguous stands of ash in southeastern Wisconsin are now dead. Minnesota and Missouri detected the EAB in 5 and 14 new counties, respectively.

The EAB is present throughout the Southern Region where it continues to spread across most of the 11 States with the exceptions of Mississippi and Florida. Detection in Oklahoma remains limited to a single trap detection in 2016. Throughout much of this region, mortality is growing in urban areas, local parks, and along waterways and roadways where ash is common. States anticipate the continued spread of the EAB throughout undetected areas over the next couple of years.

In Alabama, the EAB is spreading towards the larger cities in the northern part of the State where ash is an important component of the urban landscape.

In Kentucky, where approximately two-thirds of the State is impacted and neighboring states are infested, the EAB is expected to be confirmed throughout the State within the coming years. In Virginia, the EAB has become common, and signs are evident in neighborhoods, along roads, riverbanks, and natural areas.

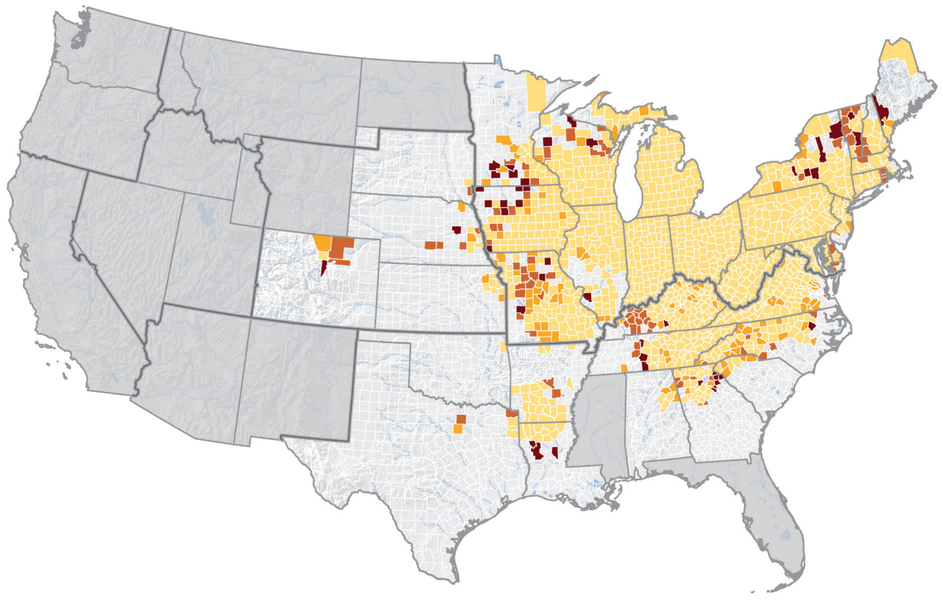
In the western regions, the EAB remains known only in Colorado, Kansas, Nebraska, and South Dakota. Detection of new county infestations were made in Nebraska. Ash in the impacted areas continues to decline through EAB-caused mortality and preemptive tree removal.

HOST: **ASH**

- **Continues to spread** to additional counties in infested States, but no new States in 2021
- **Ash mortality is extensive** in impacted natural forests and communities

Tree mortality caused by the emerald ash borer. Photo by Ryan Armbrust, Kansas Forest Service, Bugwood.org.

FOREST DAMAGE AND RANGE



Fir Engraver

Scolytus ventralis

Drought conditions increase tree mortality caused by fir engraver.

Tree mortality caused by the fir engraver. Photo by William M. Ciesla, Forest Health Management International, Bugwood.org.

Tree mortality caused by the fir engraver continued throughout the Western United States in 2021. Increased mortality from the fir engraver was associated with drought in Arizona, New Mexico, Washington, Oregon, California, Montana, Idaho, and Utah. All fir species are impacted.

In the Southwest, a large increase in white fir mortality was attributed to the fir engraver in Arizona and New Mexico. Arizona observed mortality on the Coconino National Forest, Coronado National Forest, Grand Canyon National Park, and White Mountain Apache Tribal lands; New Mexico reported mortality on the Cibola National Forest and Santa Fe National Forest.

In the Pacific Northwest, tree mortality caused by the fir engraver continued, particularly in overstocked stands of fir on drought-prone sites and in trees infected with root disease. In Oregon, tree mortality is most concentrated in mid-elevation areas where site quality, aspect, or other microclimate factors have intensified drought impacts. Mortality caused by the fir engraver is widespread in Washington.

In California, fir mortality attributed to the fir engraver beetle comprised over 64 percent of the total tree mortality observed in 2021. The State recorded approximately 6.1 million dead firs across 780,000 acres. White fir mortality was concentrated in overstocked lower elevation stands on the Modoc National Forest and in the Barton Flats area on the San Bernardino National Forest. In the southern Sierras, true fir mortality was associated with the fir engraver, very high summer temperatures, and prolonged drought. The fir engraver was identified on the Sierra National Forest targeting mostly large-diameter, fire-injured trees.

Surveyors continued to detect the fir engraver across Idaho, Montana, Nevada, and Utah. In northern Idaho and Montana, most of the mortality caused by the fir engraver was on National Forest System lands. In northern Idaho, Clearwater and Shoshone Counties had the highest acreages of damage recorded. In Montana, Lincoln, Sanders, and Flathead Counties reported high levels of activity. Nevada observed tree mortality caused by the fir engraver on 610 acres. In southwestern Idaho and Utah, tree mortality caused by the fir engraver remained at low levels.

Fir engraver adult. Photo by Donald Owen, California Department of Forestry and Fire Protection.

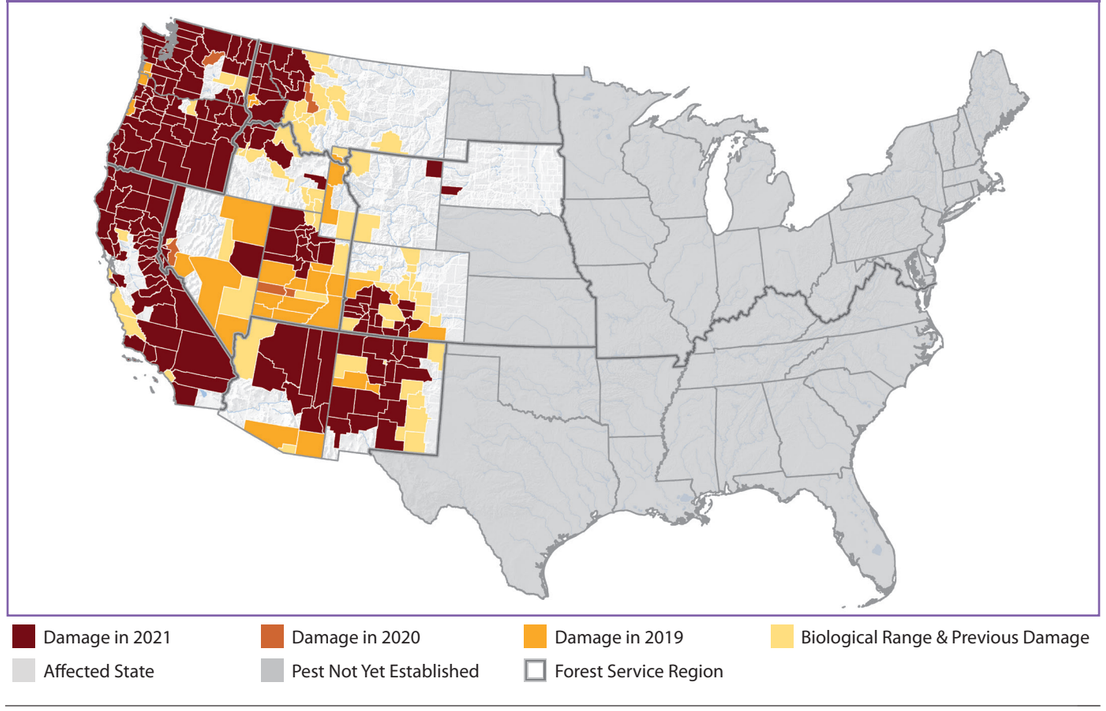
White fir mortality caused by the fir engraver. Photo by William M. Ciesla, Forest Health Management International, Bugwood.org.

HOST: **WESTERN FIRS**

- **Drought conditions increased** fir mortality
- **1 million acres** with tree mortality was reported

Fir engraver beetle galleries. Photo by Fred Honing, USDA Forest Service.

FOREST DAMAGE AND RANGE



Spongy Moth

Lymantria dispar dispar

The most extensive activity by the spongy moth ever documented in Michigan occurred in 2021.

Male (brown) and female (white) adult spongy moths. Photo by John Ghent, Bugwood.org.

Defoliation caused by the spongy moth increased to 2.5 million acres nationally from 960,000 acres in 2020. Michigan reported more than half of the 2.5 million acres, with significant increases also occurring in New York and Pennsylvania.

New York mapped nearly 700,000 acres of defoliation by the spongy moth in 2021. Defoliation was significant in many areas and observed on both hardwoods and conifers. Wet weather in June and July in the Finger Lakes region promoted an increased presence of Nucleopolyhedrosis virus (NPV) and *Entomophaga maimaiga* resulting in high caterpillar mortality. Outside of that area the impact of epizootic disease was less.

The spongy moth caused areas of severe defoliation in western Massachusetts where more than 11,000 acres of defoliation were detected. Vermont reported the first year of a spongy moth outbreak affecting 51,000 acres, predominately in oak forests in the Champlain Valley region. Connecticut reported more than 45,000 acres with defoliation in the western part of the State. No defoliation was observed in Rhode Island.

In Maine, approximately 55,000 acres of defoliation was reported statewide. Surveyors reported extensive damage in southern Oxford County, where larvae consumed vegetation on both hardwood and less-preferred conifer hosts. Damage was mostly confined to core areas in western Maine contiguous with the 36,000 acres of defoliation across the border in New Hampshire.

The mid-Atlantic States of Delaware, West Virginia, and Ohio reported limited to no defoliation by the spongy moth. Pennsylvania experienced high levels of the spongy moth activity with many large areas of severe defoliation. The 315,000 acres reported in Pennsylvania is a 5-year high. In New Jersey, the spongy moth defoliated more than 10,000 acres, mostly in the southern part of the State. Maryland reported 21,000 acres in the southeastern part of the State.

The Central States of Iowa, Illinois, and Missouri did not report any tree damage from the spongy moth. Less than 1,000 acres of defoliation were reported from Wisconsin and Indiana. Minnesota reported an infestation in Lake County, but observed no defoliation.

Spongy moth populations continued to expand in the northern Lower Peninsula of Michigan following a rapid increase in 2020. Michigan conducted an extensive aerial survey of roughly 24 million acres, more than double the survey acreage flown in 2020.

The 1.285 million acres of defoliation in the State was the most extensive defoliation by the spongy moth ever documented in Michigan.

In the South, defoliation by the spongy moth was reported only in Virginia where eight counties reported damage totaling 18,538 acres of light and moderate defoliation. The spongy moth continued to be collected in traps in other Southern States.

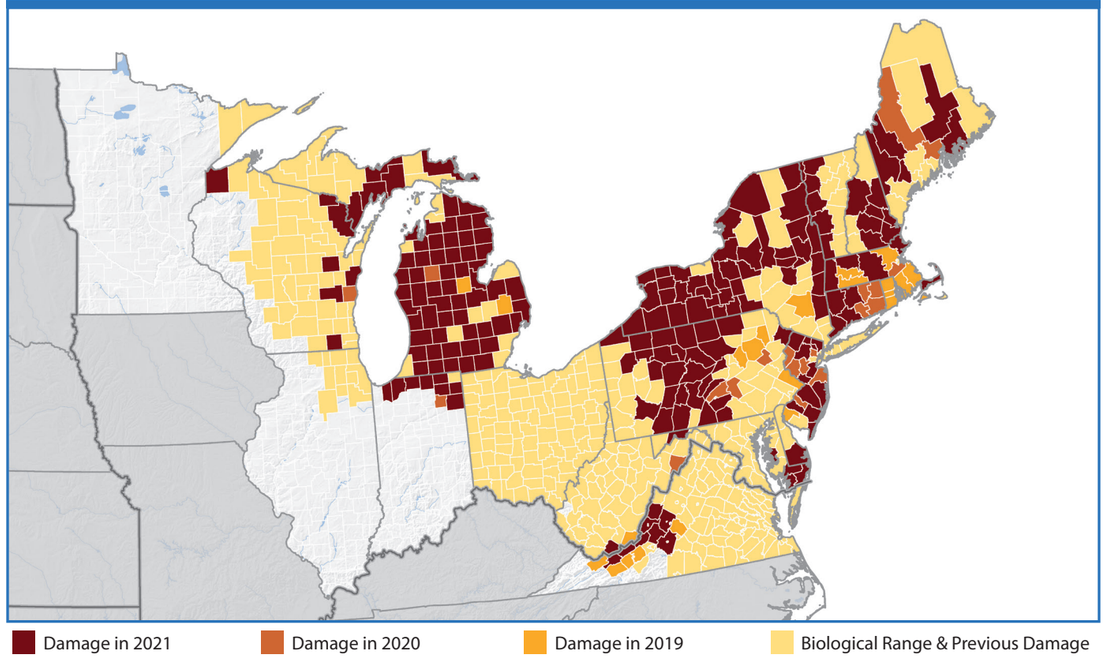
Across the Western United States, the Forest Service conducted pheromone-based male spongy moth trapping surveys in coordinated efforts with USDA's Animal and Plant Health Inspection Service (APHIS) and State and Tribal agriculture departments. Annual monitoring and detection traps were negative in the Western States with three exceptions—Montana, Washington, and California. One detection of *Lymantria dispar asiatica* occurred in Washington in Stevens County. Delimiting trappings in Montana, North Dakota, and Oregon conducted in response to positive catches in previous years were negative in 2021.

HOST: **HARDWOODS**

- **2.5 million acres** with defoliation reported
- **1.3 million acres** is the **most extensive defoliation** ever documented in Michigan

Defoliation in hardwoods caused by the spongy moth. Photo by Karla Salp, Washington State Department of Agriculture, Bugwood.org.

FOREST DAMAGE AND RANGE



Oak Wilt

Bretziella fagacearum

Oak wilt in northern pin oak. Photo by Joseph O'Brien, USDA Forest Service.

An aggressive tree disease of oaks.

Oak wilt is an aggressive tree disease that impacts oaks. Oak wilt affects both red and white oak species killing oaks in forests, woodlots, and community landscapes throughout New England and the mid-Atlantic, Central, and Southern States of Ohio, Pennsylvania, Maryland, West Virginia, New York, Iowa, Indiana, Michigan, Missouri, Wisconsin, Minnesota, South Carolina, and Texas.

In the Northeast, oak wilt is widely distributed in Pennsylvania, Ohio, Maryland, West Virginia, and New York.

Pennsylvania reported oak wilt in three new counties. In Indiana, 66 of 92 counties have confirmed occurrence of oak wilt. Franklin County in Indiana had oak wilt confirmed for the first time in 2021. Minnesota confirmed its first reports in Cass and Crow Wing Counties.

South Carolina detected additional oak wilt infestations in Lexington County. Most of the infected trees are water oaks, though southern red oak, live oak, and willow oaks are all in proximity to these disease centers. Oak wilt continued to occur in 76 counties in central and west Texas from Dallas to Lubbock to San Antonio. The Cooperative Oak Wilt Suppression Project continued trenching activities in 2021 to help control the spread of oak wilt through root grafts.

Northern pin oak mortality caused by oak wilt. Photo by Steven Katovich, Bugwood.org.

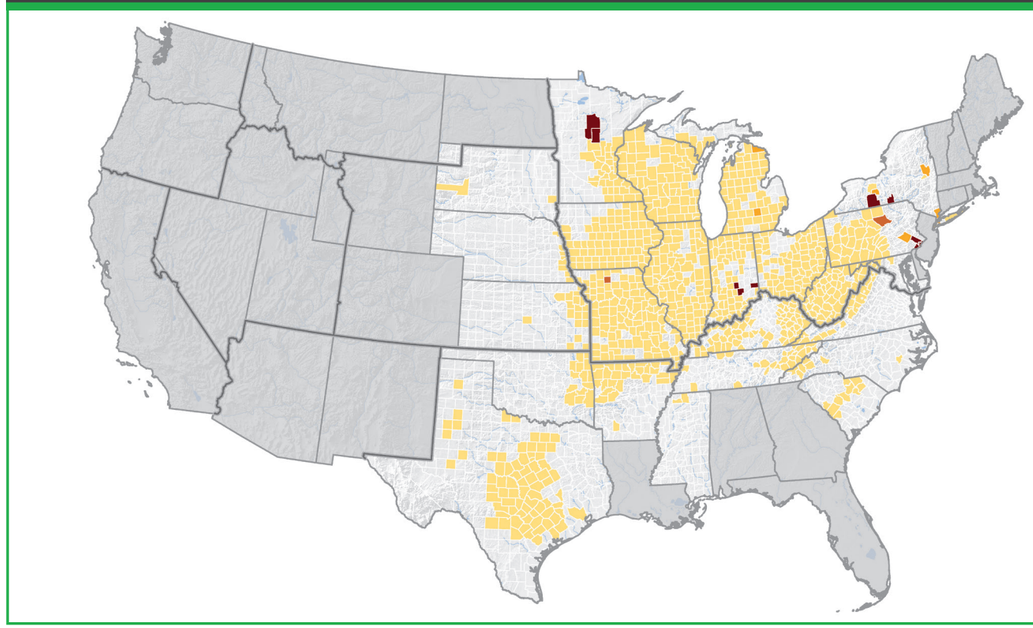
Foliar decline in red oak caused by oak wilt. Photo by Joseph O'Brien, USDA Forest Service.

HOST: **OAK**

- ★ An **aggressive tree disease** of red oak species
- ★ **Actively spreading** among oaks damaged or trimmed during April, May, or June each year

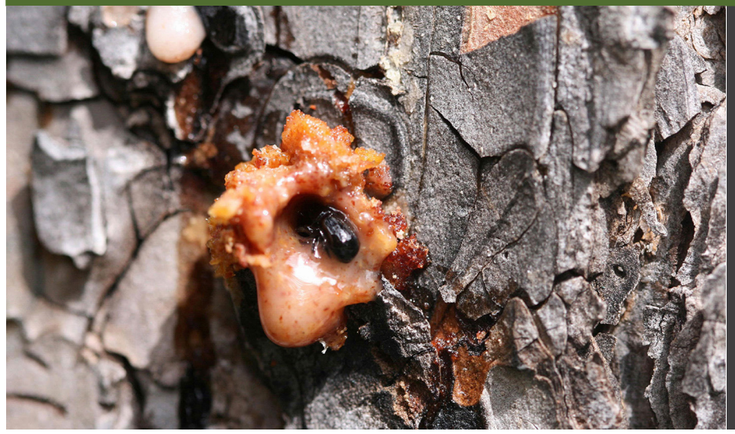
Foliar decline caused by oak wilt. Photo by Joseph O'Brien, USDA Forest Service.

FOREST DAMAGE AND RANGE



Mountain Pine Beetle

Dendroctonus ponderosae



Mountain pine beetles attack a ponderosa pine. Photo by Whitney Cranshaw, Colorado State University, Bugwood.org.

Mountain pine beetle impacts are greatest in drought-impacted areas.

The mountain pine beetle (MPB) continued to be active across the Western United States. Mountain pine beetle populations were largely reported as endemic, causing only scattered pockets of mortality, through much of the West.

In the Pacific Northwest, the MPB continued to be active in dense stands of lodgepole pine with some spillover into other pine types. In Washington, the MPB was active in lodgepole pine in Yakima, Kittitas, Chelan, Okanogan, Pend Oreille, and Stevens Counties. Mortality of whitebark pine caused by the MPB was reported at the highest level since 2013. Mortality was concentrated in Yakima, Chelan, and Okanogan Counties. In 2021, aerial surveys over known MPB-impacted stands did not occur in southwest Oregon due to smokey conditions. Ground observations supplemented aerial survey observations in Bakes, Grant, and Klamath Counties.

In California, pine mortality attributed to the MPB remained increased on 44,000 acres in 2021. Mortality was observed in whitebark, lodgepole, limber, sugar, and western white pine. Mortality in lodgepole and whitebark pine was scattered and mostly occurred in small groups of less than 20 trees. Increased mortality was observed in lodgepole pine near Donner Summit on the Tahoe National Forest and in whitebark pine in the central Sierra Nevada Range.

Small pockets of less than 500 acres were reported in western Wyoming and Utah.

Several areas in the Central Rocky Mountains, primarily in southern Colorado, reported increasing MPB activity. Most notable is an expanding outbreak in Taylor Basin on the Gunnison Ranger District of the Grand Mesa, Uncompahgre, and Gunnison National Forests. Favorable conditions have allowed the MPB to infest new areas near Crested Butte, CO. This area is on the edge of approximately 300,000 acres of mature lodgepole pine that was unaffected by the MPB epidemic in the 2000s. A second area in ponderosa pine was reported east of Buena Vista, CO. Throughout the rest of Colorado, Wyoming, and South Dakota, tree mortality caused by the MPB occurred infrequently.

In the Southwest, MPB activity was minimal across Arizona with less than 5 acres recorded during aerial detection surveys. Several areas of concern for potential activity in fire-impacted southwestern white pines were monitored including two "sky islands"—the Pinaleño Mountains and Mount Lemmon—but no activity was detected.

In the Northern Rockies, the MPB remains largely endemic, occurring on approximately 8,000 acres across the region. About 90 percent of the activity was observed in lodgepole pine in Montana. Tree mortality caused by the MPB was also observed in ponderosa, whitebark, and limber pines.

Across the Intermountain Region, MPB activity was endemic with scattered mortality on approximately 5,500 acres. Most of the mortality caused by the MPB was reported in southwestern Idaho and in Nevada around Great Basin National Park. Two localized MPB outbreaks are occurring in Nevada with mortality in limber and bristlecone pine in the Upper Lehman Basin and on Mount Moriah, and in whitebark pine in the Jarbidge Mountains and Lamoille Canyon.

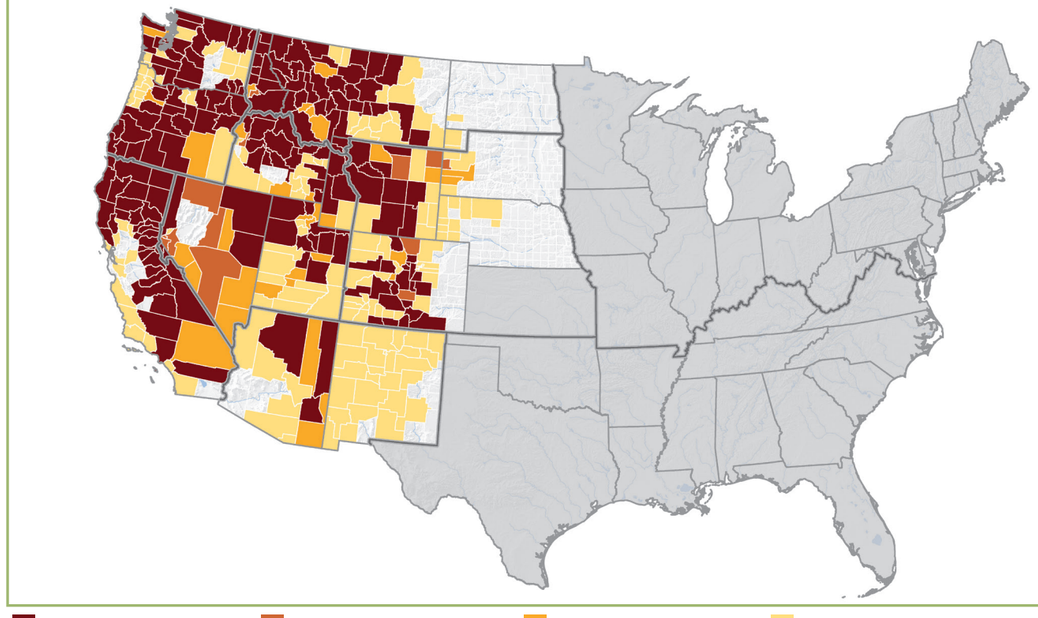
Mortality of lodgepole pine caused by the mountain pine beetle. Photo by Dave Powell, USDA Forest Service.

HOST: **WESTERN PINES**

- **Continued activity** across the Western United States
- Tree mortality caused by the mountain pine beetle **increased in California**

Mountain pine beetle galleries. Photo by William M. Ciesla, Forest Health Management International, Bugwood.org.

FOREST DAMAGE AND RANGE



Spruce Budworm

Choristoneura fumiferana

Spruce budworm larva. Photo by USDA Forest Service, Alaska Region.

Michigan outbreak nears conclusion.

The spruce budworm (SBW) is a native defoliator of spruce and fir trees in mixed coniferous forests. Severe defoliation by the SBW can result in tree mortality, impacting timber production and reducing socioeconomic benefits of forests. In 2021, the SBW impacted States across the northern Midwest and Northeast, including Minnesota, Michigan, and Maine. No significant defoliation by the SBW was observed in New York or Vermont in 2021.

In Maine, aerial surveys observed evidence of building SBW populations, where defoliation was visible from the air for the first time since the early 1990s. In total, surveyors documented around 850 acres in northern Aroostook County. Maine continues its intensive monitoring program that includes trapping, larval sampling, and ground and aerial surveying to determine treatment strategies.

In Minnesota, nearly 400,000 acres of defoliation and tree mortality were attributed to the SBW. In Michigan, aerial detection and field surveys reported a decrease in defoliation by the SBW in 2021 suggesting that the outbreak in the Upper Peninsula counties may be nearing an end, although localized infestations are likely to continue. In the Lower Peninsula, some pockets of mortality were observed in the central and northeastern area where locally heavy populations occur periodically and usually collapse before serious tree mortality occurs.

Dead and dying balsam fir following persistent defoliation by eastern spruce budworm. Photo by Steven Katovich, Bugwood.org.

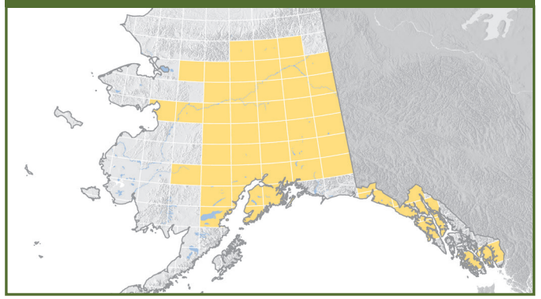
Defoliation symptoms of spruce caused by spruce budworm. Photo by Joseph O'Brien, USDA Forest Service, Bugwood.org.

Spruce budworm adult. Photo by USDA Forest Service, Alaska Region.

HOST: **SPRUCE, FIRS, DOUGLAS-FIR**

- A **native defoliator** in mixed coniferous forests
- **Reduces tree growth and vigor,** increasing susceptibility to other insects and diseases

FOREST DAMAGE AND RANGE



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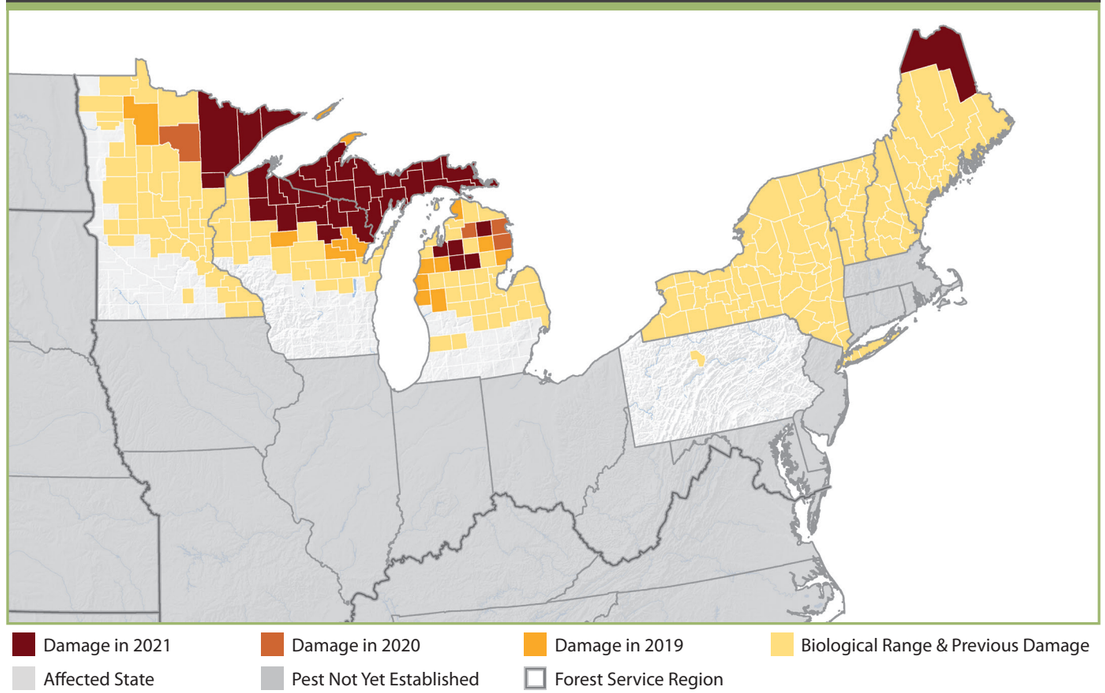


Spruce Beetle

Dendroctonus rufipennis

Host depletion changes outbreak dynamics.

Spruce mortality caused by the spruce beetle in Susitna Valley, AK. Photo by Steve Swenson, USDA Forest Service.

Alaska observed spruce beetle activity on approximately 193,500 acres statewide during aerial detection surveys in 2021. Nearly all activity of the spruce beetle was mapped within southcentral Alaska, where an ongoing outbreak is now estimated to be in its sixth year. The outbreak has affected at least 1.6 million cumulative acres of mixed spruce and birch forests since 2016. In areas with near exhaustion of white spruce, the spruce beetle has been confirmed in black spruce. In 2021, the outbreak was most active in the northern Matanuska-Susitna Borough, the lower Denali Borough, and in parts of the Kenai Peninsula. Activity has greatly declined in the areas most severely impacted early in the outbreak.

In the Intermountain Region, aerial surveys indicated that tree mortality caused by the spruce beetle continued with approximately 37,000 acres impacted. Most of the spruce mortality was mapped in Utah on National Forest System lands. The Ashley National Forest and Bridger-Teton National Forest continue to have significant outbreaks of the spruce beetle.

In the Central Rocky Mountains, spruce beetle populations continue to expand where there are suitable hosts. There are many large areas with ongoing activity that have little mature spruce remaining. In Wyoming, the Shoshone National Forest continued to experience high levels of mortality caused by the spruce beetle on the Wind River District south of Togwotee Pass. The spruce beetle is scattered in the northern Bighorns. Colorado observed 53,000 acres of widespread activity in and around Rocky Mountain National Park, Mount Evans, and the southern part of the State. Increased activity is reported in the West Elks, Sawatch Range, and near Silverton, CO.

In the Southwest, mortality caused by the spruce beetle occurred in Arizona and New Mexico. In Arizona, spruce beetle damage was observed on the Kaibab National Forest, Coconino National Forest, Apache-Sitgreaves National Forests, and the White Mountain Apache Tribal lands. In New Mexico, tree mortality from the spruce beetle was primarily observed on the Carson National Forest, Santa Fe National Forest, and adjacent lands. Some stands have experienced several years of activity and surveyors have recorded greater than 90 percent spruce tree mortality; little new activity was observed in these areas.

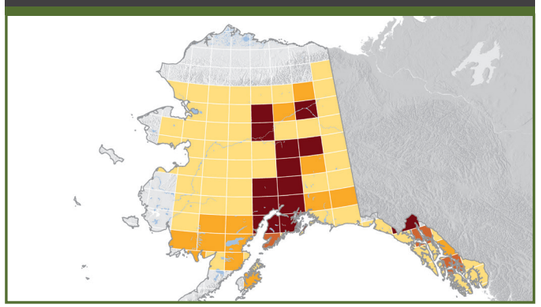
Mortality in Engelmann spruce caused by the spruce beetle. Photo by William M. Ciesla, Forest Health Management International, Bugwood.org.

Spruce beetle adult. Photo by Stephen Burr, USDA Forest Service.

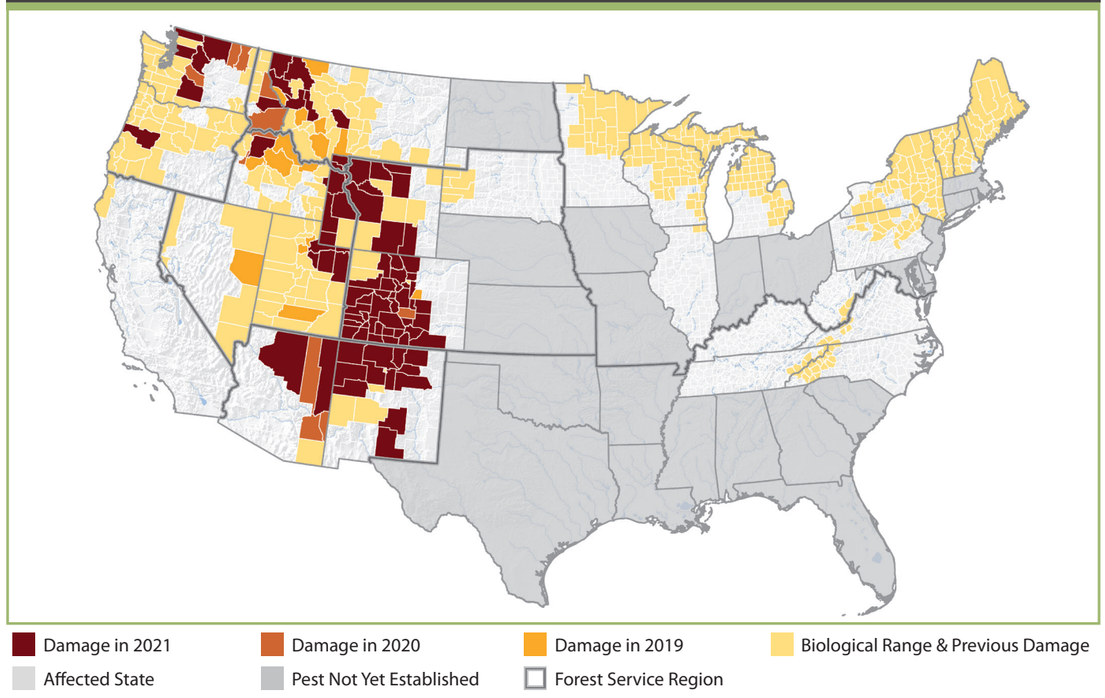
HOST: **SPRUCE**

- **Attacks spruce trees across its range** in North America
- **Mortality continues** across the Western United States

FOREST DAMAGE AND RANGE



FOREST DAMAGE AND RANGE



Douglas-Fir Beetle

Dendroctonus pseudotsugae

Tree mortality caused by the Douglas-fir beetle. Photo by A. Steven Munson, USDA Forest Service.

Drought increases tree mortality throughout the West.

The Douglas-fir beetle (DFB) is a native bark beetle that impacts Douglas-fir. Tree mortality caused by the DFB is often associated with tree stressors or injuries such as drought, fire scorching, or defoliation. Douglas-fir mortality was reported throughout the Pacific Northwest, Southwest, and the Central and Northern Rockies.

In the Pacific Northwest, mortality caused by the DFB continued in 2021. Throughout Oregon and Washington, the DFB is killing drought-affected trees. In Baker County, OR, the Douglas-fir beetle has killed trees recently defoliated by the Douglas-fir tussock moth.

In the Southwest, mortality caused by the DFB was highest on the Kaibab National Forest, Navajo Tribal lands, and within Grand Canyon National Park in Arizona. In New Mexico, DFB-caused tree mortality increased on the Carson, Cibola, Gila, Lincoln, and Santa Fe National Forests. Douglas-fir beetle activity continued in fire-stressed trees impacted by the 2018 Buzzard Fire on the Gila National Forest and the 2016 North Fire on the Cibola National Forest.

In Wyoming and Colorado, the DFB is widespread but scattered on over 8,000 acres. Prevailing drought conditions and years of heavy defoliation by the western spruce budworm in both States has increased tree mortality. Defoliation is so severe in some areas that aerial surveyors are unable to detect known DFB-caused tree mortality reported by ground surveys due to the lack of foliage. Douglas-fir beetle populations have increased in the Clarks Fork area on the Shoshone National Forest and in the southern Bighorn Mountains of Wyoming. In Colorado, portions of the Grand Mesa,

Douglas-fir beetle adults. Photo by Constance Mehmel, USDA Forest Service.

Uncompahgre, and Gunnison National Forests have very little mature Douglas-fir remaining, and as drought conditions intensify, new pockets of mortality have developed on the White River National Forest.

In the Northern Rockies, the DFB remained active with scattered pockets of localized mortality. Heavy defoliation, due to the western spruce budworm or the Douglas-fir tussock moth, obscured DFB-caused mortality in impacted stands. In Montana, most mortality caused by the DFB occurred on the Lolo National Forests, the Helena-Lewis and Clark National Forest, and private lands. In northern Idaho, most mortality in Douglas-fir was mapped on the Idaho Panhandle National Forests.

In the Intermountain Region, scattered mortality caused by the DFB was noted on around 8,500 acres on most of the region's national forests. Almost half of the regional damage was observed in Idaho on the Boise National Forest. In Utah, aerial detection surveys mapped trees killed by the DFB on approximately 1,100 acres scattered across forests.

HOST: **DOUGLAS-FIR**

- **Mortality** often associated with tree stressors and injury
- **Drought-affected tree mortality** apparent in most western States

Red-orange boring dust from the Douglas-fir beetle is evidence of a successful attack. Photo by Sandy Kegley, USDA Forest Service.

FOREST DAMAGE AND RANGE